

CLAIMS

What is claimed is:

1. A method of analyzing a model for Model Predictive Control, the method comprising the steps of:
 - 5 a) obtaining a model gain matrix of a subject model used for Model Predictive Control of a given process;
 - b) identifying any near-collinear sub-matrices of the obtained model gain matrix;
 - c) adjusting the collinearity of any identified sub-matrixes; and
 - 10 d) optimizing adjusted sub-matrixes to form a new model gain matrix for the subject model.
2. The method of Claim 1, wherein the identification step includes searching the model gain matrix with SVD.
- 15 3. The method of Claim 1, further including a step of estimating a control action magnitude.
4. The method of Claim 1, further including a step of exciting the given process in a weak direction.
- 20 5. The method of Claim 1, further including a step of verifying whether at least some portion of the given process is collinear or nearly collinear.
- 25 6. The method of Claim 5, wherein a Collinearization procedure is implemented if at least a portion of the process is verified as being nearly collinear.
7. The method of Claim 6, wherein the smallest singular values in at least one subset of the model are set to exactly zero.

8. The method of Claim 5, wherein the directionality of the subset of the model is unchanged.
9. The method of Claim 5, wherein an Uncollinearization procedure is
5 implemented if at least one portion of the process is verified as being noncollinear.
10. The method of Claim 1, wherein the method is simultaneously applied to more than one subset of the model.
- 10 11. The method of Claim 1, wherein the method is applied to a square matrix or a square matrix subset that is at least 2x2 in size.
12. The method of Claim 10, wherein the square matrix or square matrix subset is at
15 least 3x3 in size.
13. The method of Claim 12, wherein the square matrix or square matrix subset is at least 4x4 in size.
- 20 14. The method of Claim 12, wherein the square matrix or square matrix subset is at least 5x5 in size.
15. The method of Claim 12, wherein the square matrix or square matrix subset is at
25 least 6x6 in size.
16. A method of detecting, verifying, and repairing collinearity or near collinearity in a model, comprising the steps of:
 - a) defining bounds for a gain matrix;
 - b) specifying a collinear threshold;
 - 30 c) examining the matrix to identify all near-collinear sub-matrices;

- d) scaling at least one weak output for each near-collinear sub-matrix;
 - e) adjusting a control action magnitude;
 - f) determining what type of model repair would be desirable;
 - g) constructing a quadratic programming problem; and
 - 5 h) solving the quadratic programming problem to generate a new model matrix.
17. The method of Claim 16, further comprising the step of using an optimization formula to perfectly collinearize a selected sub-model while maintaining
- 10 directionality and minimizing model deviation.
18. The method of Claim 17, wherein the optimization formula includes at least one singular value, at least one singular vector, and a model matrix.
- 15 19. The method of Claim 17, wherein multiple sub-matrices are solved simultaneously.
20. The method of Claim 17, wherein a linear constraint is imposed, wherein the linear constraint includes the uncertainty bound in a transformed space.
- 20 21. The method of Claim 16, further comprising the step of using an optimization formula to decrease collinearity in a selected sub-model while maintaining directionality and minimizing model deviation.
- 25 22. The method of Claim 21, wherein the optimization formula includes at least one singular value, at least one singular vector, and a model matrix.
23. The method of Claim 22, wherein multiple sub-matrices are solved simultaneously.
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24. The method of Claim 22, wherein a linear constraint is imposed, wherein the linear constraint includes the uncertainty bound in a transformed space.
25. A computer program product, comprising:
- 5 a) a computer usable medium; and
- b) a set of computer program instructions embodied on the computer useable medium for detecting, verifying, and repairing collinearity or near collinearity in a model used for Model Predictive Control purposes.
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26. The computer program of Claim 25, wherein at least some portion of the computer program instructions include instructions to request data or request instructions over a telecommunications network.
- 15 27. The computer program of Claim 25, wherein at least some portion of the computer program is transmitted over a global network.
28. The computer program of Claim 25, wherein the computer usable medium includes a removable storage medium.
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29. The computer program of Claim 28, wherein the removable storage medium includes any of a CD-ROM, a DVD-ROM, a diskette, and a tape.
30. A computer system for detecting, verifying, and repairing collinearity or near collinearity in a model used for Model Predictive Control purposes, the computer system comprising:
- 25 a) a data transfer means for transferring data among components of a computer;
- b) a digital processor coupled to receive input from the data transfer means, wherein the digital processor executes a method for
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analyzing a model used for Model Predictive Control purposes,
wherein the method:

- i) detects collinearity or near collinearity in the model,
 - ii) verifies the collinearity or near collinearity in the model,
and
 - iii) repairs the collinearity or near collinearity in the model;
and
- c) an output means coupled to the digital processor, wherein the
output means provides to a user the analyzed model.

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31. The computer system of Claim 30, wherein the computer system enables
transmission of at least a portion of data over a global network.

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32. A chemical species manufactured by a process that includes the method of
Claim 16.